sary to carry this out under light general anesthesia.

Paraffin Wax Method:

More recently this method has been revived and modified by Doctor R. C. Pendleton at the Mare Island Naval Hospital. Many of those who have had experience with this method are enthusiastic about the ease and economy with which it can be carried out. This essayist has had no experience with the method and therefore does not feel qualified to present an opinion.

Infection Beneath Eschar:

If infection occurs beneath the tan or eschar, or the patient shows systemic or local signs of sepsis, the eschar should be carefully inspected. If an area looks suspicious a hole should be made through the eschar and, if pus is encountered, the entire area of suppuration should be unroofed by means of sterile sharp instruments. This can usually be done without much trauma and without anesthesia. The suppurating surface should then be treated by wet saline compresses, as for any infected granulating wound. Crystalline sulfanilamid may be applied over the exposed surfaces daily thereafter. If the area is large, no more than 15 grams of sulfanilamid should be used in any one 24-hour period, as toxicity may result.

Treatment of Granulating Areas:

It must be remembered that all third-degree burns result in granulating areas. These granulating areas must be effectively and rapidly cleaned up in preparation for skin grafting, if the patient is to be spared the septic stage of a burn during which anemia, cachexia and damage to kidneys and livers may occur. Recently we have learned that the process of "cleaning up" may be greatly accelerated by the daily use of a light dusting of sulfanilamid crystals and the application of compresses to the area, thus permitting the application of skin-grafts earlier than heretofore. Dressings always should be as painless as possible.

Oral Administration of Sulfonamide Drugs:

Although it has not been routinely our custom to give sulfa drugs by mouth to patients with severe burns, sulfadiazine by mouth may be administered, particularly if the definitive treatment is delayed. This drug has been chosen because it is the least toxic of the three commonly used sulfa drugs. The dosage is 1 gram every 6 hours, day and night for ten days. If sensitivity is present it may be necessary to use one of the other drugs. It is dangerous to give a sulfonamid drug to a patient who is not voiding normally over 1000 c.c. per day.

SUMMARY

1. The treatment of a severe burn should be aimed at the prevention of shock and infection.

2. The use of blood plasma in the treatment of shock has materially reduced the early mortality in severe burns. 50-100 c.c. of plasma should be administered for every per cent of the body burned.

3. Simple first aid measures may be carried out anywhere if materials are available, but definitive treatment should only be instituted where facilities are adequate.

4. Every effort should be made to minimize secondary contamination of the burn.

5. Large quantities of saline and glucose should not be administered, as they tend to intensify the edema and dilute the blood proteins.

6. Whole blood transfusions should not be used in the early-burn treatment, unless hemorrhage has occurred, or plasma is not available. Later, when anemia appears, blood transfusions are indicated.

7. Strong antiseptics or vigorous scrubbing should never be used on a burn. Plain white soap, cotton and sterile water will cleanse the area adequately.

8. The two most commonly-used methods of local therapy are the pressure dressing method and the tannic-acid and silver nitrate escharotic method.

9. All third degree burns result in granulating areas. These areas should be cleaned up as rapidly as possible in preparation for skin grafting.

10. Sulfadiazine may be administered orally to severe burns, particularly if proper therapy cannot be instituted early.

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CRUSH SYNDROME

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CRUSH syndrome was recognized clinically during the last war, but little literature was devoted to it then. It has since then, for a time, been dropped entirely from the literature of medicine. Within recent years reports have again appeared, mostly in British literature, concerning this syndrome. Most of the reported cases have been victims of bombing attacks who had been imprisoned beneath heavy débris and suffered prolonged crushing injury to a mass of muscle tissue.

The individual who has been pinned beneath fallen débris for a period of time in such a way as to have a mass of muscle tissue crushed, and its vascular supply injured, is subject to this syndrome. He may or may not show vascular shock at the time he is extricated. The presence or absence of primary shock should not in any way lead one away from being on guard against the crush syndrome. The crush syndrome may appear at any time from two to forty-eight hours following release from the compression. Crush syndrome is a toxic condition of the kidneys resulting from the absorption of broken-down muscle proteins following sudden release from pressure. It is characterized by the classical symptoms of destruction of the kidney, and its failure to perform its function of secretion. All

* One of several papers in a Symposium on "Emergency Medical Service in Wartime." Papers collected by Henry Gibbons, III.

symptoms of kidney failure appear, and death results from kidney failure.

The person giving first aid should recognize the probability of crush syndrome from the position in which he finds the victim. He should, as far as he is able, prevent the absorption of muscle protein into the circulation by the application of a tourniquet. He should then note, on the identification tag, the history of a crushing and compression muscle injury. That the victim does not show any symptom of vascular shock should be no excuse for failure to apply a tourniquet, or to make the notation on his identification tag.

This history of a sustained crushing injury is of the utmost importance to the attending physician at the receiving hospital. Regardless of primary shock, the attending physician should take all precautions against the possibility of the appearance of the crush syndrome, recalling that it is a toxic condition of the kidney resulting from rapid absorption of toxins from the ischemic crushed muscle. By the use of the tourniquet in applying intermittent pressure, he should restore the blood supply and retard the absorption of the toxin.

Primary shock should be dealt with promptly by injecting plasma. Blood pressure and blood volume should be restored. The victim who may be subject to crush syndrome will stand a far better chance of recovery if all primary shock has been cared for adequately.

When the peripheral arterial pulse has disappeared, multiple incision into the tense edmatous tissues may be indicated as a means of saving the limb. Early amputation should be done when it becomes evident that the circulation cannot be reëstablished. The patient may have injuries apart from the crushing of muscle tissue, and which may require special attention. We may help to prevent secondary shock by giving morphine for relief of pain, by splinting fractures and controlling hemorrhage.

Whether surgery has been performed or not, whether primary vascular shock has been present or not, the victim should be watched and treated with the awareness of the possibility of crush syndrome. The syndrome may begin to appear within a few hours after admission to the hospital or at any time within forty-eight hours. The rising acidity of the urine, with its typical red tinged casts and albumin, and the rising blood pressure, and the closing down of urinary secretion are indicative of kidney involvement.

Preventative measures should be begun promptly. Alkalinization of the urine is important. Alkalis should be given until the urine remains alkaline to litmus. Methyl red should be used, however, to detect the degree of acidity. If the urine cannot be made alkaline to methyl red, the prognosis is grave. Intravenous alkalies may be necessary to maintain an alkaline urine. Five per cent sodium bicarbonate solution intravenously, as used in the last war, may be employed in order to maintain an alkaline urine.

Fluids should be given for the purpose of maintaining the water balance of the body, that it may offer sufficient water for dilution of the muscle toxin in the secretion by the kidney, but not enough that it may cause edema of the crushed muscle.

Normal saline or dilute glucose (5 per cent solution) are contraindicated because, in the presence of a highly acid urine, either will tend to cause edema. A hypertonic solution of 2 per cent magnesium sulphate or 15 to 20 per cent glucose solution are to be preferred for their dehydrating effect on the swollen kidney. The kidney, swelling within its capsule, tends to compress its own blood supply, thereby doing additional damage to that already present. Solutions given should tend to prevent edema of the kidney.

Plasma should be given with the idea of sustaining the blood volume. Too much plasma, especially when the blood pressure is normal or is beginning to rise from damage to the kidneys, may be dangerous in that it will hold the water against kidney excretion.

The blood chemistry of the crush syndrome shows at its very beginning a rise in the N.P.N., and frequent laboratory checks of the N.P.N. may greatly help in the detection of an oncoming crush syndrome.

COMMENT

With a stepping up of bombing incidents, we would expect more crushing injuries among the civilian population, and an increase in the number of cases presenting the crush syndrome. Such injured person should be carefully watched, and shock and kidney damage should be forestalled. If evidences of beginning shock or kidney damage appear, antishock treatment should be instituted promptly and the kidneys protected against damage by retarding entrance of toxins into the blood by use of a tourniquet, by alkalization, and by giving fluids to maintain water balance.

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CHEMICAL WARFARE AGENTS: CASUALTIES THEREFROM*

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THE agents which have been used in chemical warfare may be separated into a half-dozen groups, according to their effects on the body. Of these, lacrimators and sternutators require little or no medical care because of the short duration of their action; while serious, the main systemic poisons cause syndromes with which physicians have become familiar in civil practice. Moreover, tacticians do not expect the enemy to use lacrimators, sternutators or systemic poisons against civilians in this country.

If the enemy comes, however, he may be expected to bring incendiaries, lung irritants and vesicants. A knowledge of the general aspects of

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From the Department of Medicine, Stanford University Medical School. This work is based on Civilian Defense publications.